

to the electron orbitals of neighboring atoms in a crystal. Suppose aluminum oxide (colorless sapphire) is doped with 1% Cr_2O_3 ; each of the five 3d orbitals of the resulting Cr^{3+} ions is shifted, but not all by the same amount. Light of the proper color will cause transitions involving these split levels, and will therefore be absorbed. Two such resonance absorptions are in the violet and the green-yellow (broadened by vibrational interactions), leaving deep red and a little blue to pass through. As a result, we have the blood red of the ruby.

The spatial symmetry of the ligands causes resonances to differ along different axes. Therefore the color of the transmitted light will depend upon its plane of polarization, varying between purple-red and orange-red—an effect known as pleochroism. Increase the Cr_2O_3 doping to 10% and the ligand fields are weakened, giving a colorless crystal. Heat this crystal, reducing the fields still further, and a green color results, an effect known as thermochroism. Increasing the Cr_2O_3 concentration to 60% also produces a green color; but now subject the crystal to enormous pressures of, say, 100 kilobar, and the ruby red color returns—an effect called piezochroism.

I have minor disagreements with Nassau's placement of some topics. For example, the spectacular blue interference colors of the *Morpho* butterfly are described in the chapter "Colorants of Many Types," rather than in "Interference and Diffraction." Holography is treated in a hodge-podge chapter that includes the physiology and biochemistry of human vision; it, too, seems better suited to the chapter on "Interference and Diffraction." However, I cannot fault Nassau for omissions; this is the most complete book I know of at any level on the causes of color. There are extensive discussions of color produced by molecular vibrations and rotations, band gaps and charge transfer effects, interference, diffraction, dispersion and scattering—even 19 varieties of luminescence—to name but a few of the topics.

The Physics and Chemistry of Color is to be strongly recommended, both as a reference and as an ideal text for "special topics" classes on color.

DAVID G. STORK
Swarthmore College

book note

Newton at the Bat:

The Science in Sports

Edited by Eric W. Schrier
and William F. Allman

178 pp. Scribners, New York, 1984, \$14.95

Why does a boomerang come back? This question and many others pertain-

ing to the physics of sports are answered in this collection of essays that have been contributed to *Science 84* by a number of authors. The book is divided into four parts: "Balls and Other Flying Objects" discusses the physics of the motion of baseballs, golf balls, frisbees and the like; the second part, "Gear," deals with tennis racquets, bikes, skis, sails and gliders as viewed from the scientist's eye; the third part,

"The Body," addresses the physiological aspects of sports, such as weight control, perspiration and the biophysical aspects of the exercising body; and the last part, "Form," is an amalgam of essays on subjects ranging from the ballistics of skiing to the construction of darts.

To those active in sports, *Newton at the Bat* will supply a theoretical backing that will make sports much more



VIDEO "TIME EXPOSURES"

The Colorado Video Model 493 Video Peak Store is an instrument with unique recording capabilities. The 493 will take "snapshots". It will then add new data to that already in memory if the input signal subsequently contains information of higher peak amplitude than that previously recorded.

Potential applications include: capture of random events, electro-optic scan conversion, target tracking, and certain types of noise reduction.

Features include: full frame or single field display, operation from monochrome or NTSC color video signals, and positive or negative peak recording.

(303) 444-3972

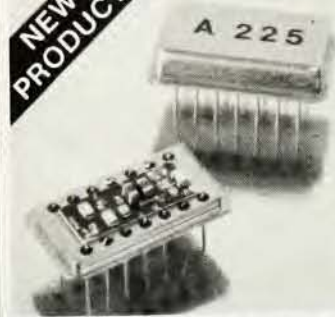
COLORADO VIDEO

Box 928 Boulder, Colorado 80306
TWX 910-940-3248 (COLO VIDEO BDR)

Circle number 32 on Reader Service Card

CHARGE SENSITIVE PREAMPLIFIERS

NEW
PRODUCT



FEATURING

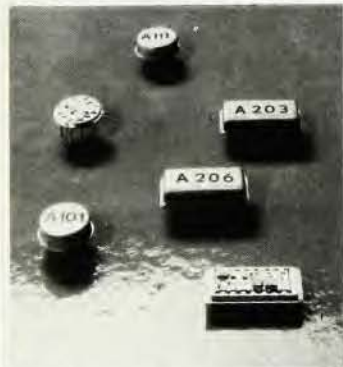
- Thin film hybrid technology
- Small size (TO-8, DIP)
- Low power (5-18 milliwatts)
- Low noise
- Single supply voltage
- 168 hours of burn-in time
- MIL-STD-883/B
- One year warranty

APPLICATIONS

- Aerospace
- Portable instrumentation
- Mass spectrometers
- Particle detection
- Imaging
- Research experiments
- Medical and nuclear electronics
- Electro-optical systems

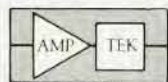
ULTRA LOW NOISE < 280 electrons r.m.s.I

Model A-225 Charge Sensitive Preamplifier and Shaping Amplifier is an FET input preamp designed for high resolution systems employing solid state detectors, proportional counters etc. It represents the state of the art in our industry!



Models A-101 and A-111 are Charge Sensitive Preamplifier-Discriminators developed especially for instrumentation employing photomultiplier tubes, channel electron multipliers (CEM), microchannel plates (MCP), channel electron multiplier arrays (CEMA) and other charge producing detectors in the pulse counting mode.

Models A-203 and A-206 are a Charge Sensitive Preamplifier/Shaping Amplifier and a matching Voltage Amplifier/Low Level Discriminator developed especially for instrumentation employing solid state detectors, proportional counters, photomultipliers or any charge producing detectors in the pulse height analysis or pulse counting mode of operation.



AMPTEK INC.

6 DE ANGELO DRIVE, BEDFORD, MA 01730
U.S.A. TEL: (617) 275-2242
With representatives around the world.

enjoyable. More sedentary people, but lovers of theories, will also be fascinated by this book—and the varied and colorful collection of topics will perhaps induce them to leave their armchairs and try out some of those theories in the field. —AH

new books

Atomic, Molecular and Chemical Physics

Orienting Polymers. *Lecture Notes in Mathematics 1063.* Proc. University of Minnesota, Minneapolis, 1983, J. L. Ericksen, ed. 163 pp. Springer-Verlag, New York, 1984. \$9.50

Rare Gas Solids. *Springer Tracts in Modern Physics 103.* H. Coufal, E. Lüscher, H. Micklitz, R. E. Norberg, 99 pp. Springer-Verlag, New York, 1984. \$24.00

Swarms of Ions and Electrons in Gases. W. Lindinger, T. D. Mark, F. Howorka, eds. 311 pp. Springer-Verlag, New York, 1984. \$31.50. *Compendium*

Kinetics of Heterogeneous Catalytic Reactions. M. Boudart, G. Djega-Mariadassou, 222 pp. Princeton U. P., Princeton, N.J., 1984. \$35.00 hardcover; \$13.50 paper. *Monograph*

Wavefunctions and Mechanisms from Electron Scattering Processes. *Lecture Notes in Chemistry 35.* F. A. Gianturco, G. Stefani, eds. 279 pp. Springer-Verlag, New York, 1984. \$19.70. *Compendium*

Quantum Chemistry of Polymers: Solid State Aspects. *NATO ASI Series.* J. Ladik, J.-M. Andre, eds. 422 pp. Reidel, Boston, 1984. \$59.00. *Compendium*

Isotope Shifts in Atomic Spectra. W. H. King, 208 pp. Plenum, New York, 1984. \$37.50. *Monograph*

Electromagnetic Radiation Properties of Foods and Agricultural Products. N. N. Mohsenin, 673 pp. Gordon and Breach, New York, 1984. \$99.00. *Monograph*

Multiphoton Spectroscopy of Molecules. S. H. Lin, Y. Fujimura, H. J. Neusser, E. W. Schlag, 260 pp. Academic, New York, 1984. \$59.00. *Monograph*

Multiphoton Ionization of Atoms. S. L. Chin, P. Lambropoulos, eds. 272 pp. Academic, New York, 1984. \$59.50. *Compendium*

Experimental Methods of Polymer Physics. A. Ya. Malkin, ed. 520 pp. Prentice-Hall, Englewood Cliffs, N.J., 1983. \$38.95. *Compendium*

Student Texts and Popularizations

Lectures on Electromagnetic Theory. L. Solymar, 251 pp. Oxford U.P., New York, 1984. \$18.95. *Undergraduate text*

Frozen Star. G. Greenstein, 274 pp. Freulich, New York, 1984. \$16.95. *Lay readers*

Improve Your Physics Grade. R. Aaron, 250 pp. Wiley, New York, 1984. \$10.95. *Elementary text*

Physics. E. R. McCliment, 913 pp. Harcourt Brace Jovanovich, New York, 1984. \$29.95. *Undergraduate text*

The Hidden Sun: Solar Eclipses and Astrophotography. J. Lowenthal, 107 pp. Avon Books, New York, 1984. \$5.95. *Lay readers*

Astronomical Experiments. Third Edition. V. Icke, 198 pp. Burgess, Minneapolis, Minn., 1983. *Undergraduate text*

Atomic and Quantum Physics: An Introduction to the Fundamentals of Experiments and Theory. H. Haken, H. C. Wolf, 394 pp. Springer-Verlag, New York, 1984. \$29.00. *Undergraduate text*

The Experience of Science: An Interdisciplinary Approach. M. Goldstein, I. Goldstein, 400 pp. Plenum, New York, 1984. \$22.50

Time, Space and Things. Second Edition. B. K. Ridley, 177 pp. Cambridge U. P., New York, 1984. \$29.95 hardcover; \$9.95 paper. *Lay readers*

Theoretical Concepts in Physics: An Alternative View of Theoretical Reasoning in Physics for Final-year Undergraduates. M. S. Longair, 366 pp. Cambridge U. P., New York, 1984. \$49.50

Relativity Physics. *Student Physics Series.* R. E. Turner, 141 pp. Routledge, Boston, 1984. \$9.95. *Undergraduate text*

Electricity and Magnetism. *Student Physics Series.* E. R. Dobbs, 122 pp. Routledge, Boston, Mass., 1984. \$9.95. *Undergraduate text*

Classical Mechanics. *Student Physics Series.* B. P. Cowan, 111 pp. Routledge, Boston, 1984. \$9.95. *Undergraduate text*

Essential Mathematics for College Physics with Calculus: A Self Study Guide. M. Ram, 418 pp. Wiley, New York, 1984. \$12.95

A Workbook for Astronomy. J. Waxman, 356 pp. Cambridge U. P., New York, 1984. \$19.95. *Undergraduate text*

Computing in Applied Science. W. J. Thompson, 325 pp. Wiley, New York, 1984. \$26.95. *Introductory text*

Miscellaneous

Nuclear War: The Medical and Biological Consequences, Soviet Physicians' Viewpoint. Y. I. Chazov, L. A. Ilyin, A. K. Guskova, 238 pp. Novosti, Moscow, 1984.

Indirect Imaging: Measurement and Processing for Indirect Imaging. Proc. of The International Symposium, Sydney, Australia, August–September 1983. J. A. Roberts, ed. 439 pp. Cambridge U. P., New York, 1984. \$54.00

Collected Works of Meghnad Saha, Vol. 1. S. Chatterjee, ed. 591 pp. Orient Longman, Bombay, 1982. Rs 75.00

Patent and Trademark Tactics and Practice. Second Edition. D. A. Burge, 213 pp. Wiley, New York, 1984. \$29.95

Metaphoric Process: The Creation of Scientific and Religious Understanding. M. Gerhart, A. M. Russell, 217 pp. Texas Christian U.P., Fort Worth, Tex., 1984. \$16.95 cloth; \$10.95 paper